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ABSTRACT

The purpose of this study was to determine if a single dimension of opportunity to learn (OTL) could be identified using four selected components of teachers', students', schools', and classrooms' characteristics, and to determine if each of the four components of OTL was related to mathematics achievement as measured by the results of the June 1999 Bahamas General Certificate of Secondary Education mathematics certificate. The primary sample consisted of 1,015 grade-12 students from 6 public and 6 private schools in New Providence, Bahamas. Complete data were available for 463 students. The secondary sample consisted of 52 mathematics teachers who taught the participating students in 10th, 11th, or 12th grades. Findings indicate that the model-data fit was reasonable, suggesting that a significant relationship existed between OTL and three selected components of teachers', students', and schools' characteristics. The fourth component, classroom's characteristics, was not related to OTL, but each of the four components was significantly related to mathematics achievement. The effects of individual indicators that made up the components are discussed, and 15 implications are drawn for school administrators, other educators, policymakers, parents, and students. (Contains 14 tables and 40 references.) (SLD)

The Effects of Four Selected Components of Opportunity To Learn on Mathematics Achievement of Grade 12 Students in New Providence, Bahamas

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Abstract

The purpose of this study was to determine if a single dimension of opportunity to learn (OTL) could be identified using four selected components of teachers, students, schools, and classrooms' characteristics; and to determine if each of the four components of OTL was related to mathematics achievement as measured by the results of the June 1999, Bahamas General Certificate of Secondary Education mathematics examination.

The primary sample of the study consisted of 1015 Grade 12 students from six public and six private schools in New Providence, Bahamas. Complete data was available for 463 students. The secondary sample in this study consisted of 52 mathematics teachers who taught the participating students in the tenth, eleventh, or twelfth grade. Both the complete and incomplete data sets were analyzed.

The findings of this study indicated that the model-data-fit was reasonable suggesting that a significant relationship existed between opportunity to learn and three selected components of teachers, students, and schools' characteristics. The fourth component, classrooms' characteristics, was not significantly related to OTL.

Each of the four components of schools, students, teachers, and classrooms' characteristics were significantly related to mathematics achievement. When the component indicators were taken individually, course taking, teaching strategies, professional development, educational background, affiliation, strength of climate, recognition, commitment, accomplishment, socioeconomic status, attitude toward school, and student's prior ability were significantly related to mathematics achievement. However, when taken individually, manipulative use, parental involvement, and years of teaching experience were not significantly related to mathematics achievement. Surprisingly, professional development, attitude toward school, strength of climate, recognition, and accomplishment were negatively related to mathematics achievement

In terms of effect size, students' characteristics made the largest contribution to mathematics achievement followed by classrooms, schools, and then teachers' characteristics. The set of students' characteristics (parental involvement not significant) explained about 60% of the variability in mathematics achievement, classrooms' characteristics (manipulative use not significant) explained about 36%, schools' characteristics explained about 12%, and teachers' characteristics (teaching experience not significant) explained about 8% of the variability in mathematics achievement.

Schools continually seek to improve instruction and student performance in mathematics throughout the Commonwealth of The Bahamas. This research includes 15 implications and recommendations for the Bahamian school administrators and policy makers, teachers, students, and parents.

The Effects of Four Selected Components of Opportunity to Learn on Mathematics Achievement of Grade 12 Students in New Providence, Bahamas

What any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning.

(Bloom, 1976, p. 7)

The concept of Opportunity to Learn (OTL) originated more than thirty-five years ago in the work of John Carroll (1963). In his model of school learning, Carroll defined OTL as the "time allowed for learning" (p. 727). Using time as the sole parameter for defining opportunity, he invited researchers to find ways of measuring opportunity to learn in terms of "the actual time available to individual students to learn in view of the pacing of instruction" (p. 732).

Over the years researchers have defined OTL in more specific terms, expanding the construct beyond the time parameter. Mathematics educators have been on the forefront of these endeavors, attempting not only to find operational definitions of OTL but also to discern the relationship between OTL and mathematics achievement. More than three decades ago, the International Association for the Evaluation of Educational Achievement (IEA) used OTL to validate its cross-national comparison studies of mathematics achievement (McDonnell, 1995). The IEA researchers used OTL to measure "whether . . . students have had opportunity to study a particular topic or learn how to solve a particular type of problem presented by the test" (Husen, 1967, p.162). Through the efforts of IEA researchers, findings of the mid-1980s on OTL began to influence the development of indicators of classroom processes to include content coverage, teaching strategies, availability and use of resources. Researchers conducting the Second

International Mathematics Survey (SIMS) concentrated on the curriculum and visualized that the curriculum operated at three levels: the intended, the implemented, and the attained curriculum. They argued that OTL should be used not only to measure the content of the curriculum but also to indicate the way the materials were presented to students (McDonnell, 1995). Shavelson, McDonnell, Oakes, Carey, and Picus (1989) asserted that the need to collect information on schools and classroom processes, to monitor educational trends, to compare conditions of schools attended by diverse groups of students in different locations, and to collect information to hold schools accountable provides a rationale to develop indicator data. Shavelson, McDonnell, Oakes, Carey, and Picus (1989) recommended that the concept of OTL be expanded even beyond that used in SIMS, to include teacher background and experience, school- and grade-level organization, course offerings and student course taking patterns, curriculum contents, availability and usage of instructional materials, and instructional strategies.

The vast amount of research related to the correlation between achievement and school processes have provided policy makers with the impetus to become interested in OTL as a measure of classroom learning and the implementation of the curriculum in different schools. Consequently, the need arose for the expansion of the types of indicators previously used in collecting and reporting data relating to OTL indicators (McDonnell, 1995).

OTL now includes not only the content of the curriculum but also how the materials are presented to students. Stevens (1996) indicated that the OTL framework must encompass factors such as content coverage, content exposure, and content emphasis. Further, Stevens insisted that the quality of instructional delivery greatly influences a teacher's instructional practices and student learning. Smithson, Porter, and Blank (1995) categorized indicators of OTL as: inputs, processes, and outputs. Researchers in the Third International Mathematics and Science Survey

(TIMSS) suggested that "educational opportunity" and "a new rhetoric about opportunity" (p. 345) should replace the traditional OTL (Schmidt & McKnight, 1995). A model of educational opportunity was developed to collect data on students' educational opportunity for the TIMSS project. The model consisted of four constructs: curriculum, classroom, school, and student variables and sought the answers to four questions: "What are students expected to learn? . . . . Who delivers the instruction? . . . . How is the instruction organized? . . . . What have students learned? . . ." (pp. 348-350). These four questions formed the basis of this research.

The Statement of the Problem

The National Education Goals Report (1996) indicated that in the United States in 1990 only 14% of Grade 8 students and 12.5% of Grade 4 and Grade 12 students respectively, had met the performance standard in mathematics set by the Goals Panel. In 1992, the mathematics performance standard in mathematics set by the Goals Panel was met by 18% of Grade 4 students, 21% of Grade 8 students, 15% of Grade 12 students. The National Education Goals Report (1997) showed that in the United States in 1996, 21% of Grade 4 students, 24% of Grade 8 students and 16% of Grade 12 students had met the Goals Panel's performance standard in mathematics. The report indicated that U. S. students' achievement in mathematics continued to fall below the performance standard set by the Goals Panel. While mathematics achievement of students in the U. S. is below standard, other countries appear to follow the same trend.

The geographical area of the Bahamas, for example, is experiencing a similar trend with regard to mathematics achievement. Many Bahamian students' scores fell below the acceptable standards in mathematics achievement as indicated by the Bahamas Junior Certificate (BJC) and the Bahamas General Certificate of Secondary Education (BGCSE) examinations. These examinations are prepared by the Testing and Evaluation Center and are administered at the end of the ninth and twelfth grade respectively. The Testing and Evaluation report on mathematics BJC and BGCSE examinations results for the school year 1997-1998, given at the opening of the Department of Education teachers' in-service workshop (August 17, 1998) indicated that the national averages for both BJC and BGCSE mathematics continued to fall below an acceptable level of achievement. The results of the mathematics BGCSE and BJC examinations alluded to serious problems in the area of mathematics and expressed reasons for grave concern and further investigation.

The purpose of this study was to examine the relationship between mathematics achievement, opportunity to learn, and the four components of teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics. This study sought answers to the following research questions:

1. What is the relationship between Opportunity to Learn (OTL) and the four selected components of teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics?
2. Is there a relationship between each of the four selected components of OTL and mathematics achievement?

Hypotheses

H_1: There is a relationship between OTL and the four selected components of teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics.

H_2: There is a significant relationship between mathematics achievement and each of the four selected components of OTL.

Participants of the Study

The primary sample for this study consisted of 1015 Grade 12 students from six public schools and six private schools in New Providence Bahamas. Questionnaires were administered to 1036 students during the Spring semester 1999. Although questionnaires were returned from 1036 students, 21of them did not give their names and as a result the researcher was unable to obtain their Bahamas Junior Certificate (BJC) and Bahamas General Certificate of Secondary Examination results. These 21 students were excluded from the study. Additionally, 552 students did not respond to all items on the questionnaires. However, the number of missing responses per item was relatively small. The secondary sample for this study consisted of 52 mathematics teachers who taught these students in the 10th, 11th, or 12th grade. Of the 60 teachers who returned the questionnaires, 52 of them were matched with the student sample and were, therefore, included in the study.

Instrumentation

A set of questionnaires, some parts developed by the researcher, others selected from published instruments, were used to collect the data and determine scores for each of the four selected components: teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics, that constitute OTL. The set of questionnaires contains a Student's Questionnaire and a Teacher's Questionnaire.

The student questionnaire was divided into two parts and consisted of 38 items. Part I contained 18 items (developed by the researcher) and were used to provide data on the selected components of students' characteristics and classrooms' characteristics. Part II of this questionnaire was a reprint of the School Climate Inventory Form-S of the Instructional Leadership Evaluation Assessment and Development Inventory (ILEAD) instrument that was printed with the permission of MetriTech Inc., the copyright holder, to collect data on schools' characteristics (1986).

The teachers' questionnaire was developed by the researcher and consisted of 15 items. This questionnaire supplied demographic data as well as data for teachers' characteristics and classrooms' characteristics.

The Measures of Mathematics Achievement

The mathematics achievement data consisted of archival data on individual students' grades from the Bahamas Junior Certificate mathematics examination which was administered to Grade 9 students in 1996 and grades from the General Certificate of Secondary Education mathematics examination that was administered to Grade 12 students in June 1999. The grades for student participants were obtained from the 1996 results of the BJC examination and the 1999 results of the BGCSE examination at The Testing and Evaluation Section of the Department of Education, New Providence Bahamas, and were used as each student's prior ability and mathematics achievement variables respectively.

Analysis of Data

The data were analyzed using structural equation modeling, confirmatory factor analysis, multiple linear regression, AMOS Version 4.0, and SPSS Version 9.0. All hypotheses were tested for significance at the .05 level. Confirmatory Factor analysis was used to test the data against a recursive second order *a priori* hypothetical structural equation model and to determine the best model-data-fit. The results from this analysis were used to test hypothesis1. Multiple linear regression was used to test hypothesis 2.

Results

Hypothesis 1 was tested using confirmatory factor analysis using the program AMOS Version 4.0 (Arbuckle, 1999) and SPSS Version 9.0.

Hypothesis 1

There is a relationship between opportunity to learn (OTL) and the four selected components of teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics.

To test hypothesis 1, structural equation modeling (Bentler, 1995) was used. The theoretically recursive *a priori* second order model was submitted to a confirmatory factor analysis using Amos Version 4.0 and SPSS Version 9.0 and maximum likelihood estimation. The original model (Figure 2) consisted of 20 endogenous (16 observed, 4 latent) variables and 21 exogenous (unobserved) variables. The variance of the second order variable OTL was set at one to set its metric (Kline, 1998). Additional constraints were needed on at least one of the parameters in the higher order structure or "this part of the model will be just-identified" (Bryne, 1994). Therefore, the variances of e17 and e20 were both fixed at one. The original model (Figure 2) was then submitted to a confirmatory factor analysis. On the first run the solution was unacceptable because the variance e10 was negative. This variance was fixed at one and the original model was resubmitted and analyzed.

The goodness-of-fit statistic (χ^2 = (103, N = 463) = 436.918, p = .000) was used with relative χ^2 /df = 4.242, RMSEA = .084. According to Kline, this was not an acceptable model-data-fit. Therefore 10 models were tested using suggested changes from the modification index provided by Amos for complete data sets. Model 10 was selected as the best-fit-model, (χ^2 = (94, N = 463) = 269.789, p = .006), with relative (χ^2 /df = 2.870, RMSEA = .064 was accepted.

Gerbing and Anderson (1993), Tanaka (1993), and Bollen (1989) suggested that the chi-square statistic should not be relied on to evaluate model fit in analyses in which the sample size is larger than 200. Therefore, the relative fit of the model was assessed using a number of comparative fit indices including root mean square error approximation (RMSEA), chi-square divided by degree of freedom (CMIN/DF), and Akaike (1987) information criterion (AIC). The RMSEA is very useful for a large model and is a measure of the discrepancy per degree of freedom in the model. The RMSEA is bounded below by zero and will only be zero if the model fits the data perfectly. RMSEA values below .05 are considered to indicate a very good fit, values less than .08 indicate a reasonable fit, and values of .1 should not be considered (Browne and Cudeck, 1993). The RMSEA for the model was .085 indicating an unacceptable model. The AIC adjusts the number of parameters and is equivalent to Bentler-Bonett (1980) Non-Normed Fit index (NNFI). When comparing two non-hierarchal models using AIC the model with the lowest AIC is preferred. Although a clear cut off point for these indices is not agreed upon, the RMSEA and CMIN/DF are evaluated against a standard of < .05 and < 3 respectively indicating an excellent fit. A CMIN/DF of < 5 is acceptable.

The standardized regression coefficients of the parameters ($\underline{\beta}$ weights) in the revised model for the OTL data set are presented in Table 12. Three of the four components of teacher (.18), student (.64), school (.81), and classroom (-.09) were significantly correlated with opportunity to learn. The highest correlations were between OTL, student, and school. The classroom, however, was negatively correlated with opportunity to learn. Professional development had the highest correlation (.73) with teacher; teaching strategies had the highest correlation (.94) with classroom; and commitment (.73) and affiliation (.75) had the highest correlations with school. The regression weights for the direct effects of three components (teachers, students, and schools) of the four components of OTL were significant at $p < .05$. (See Table12). After adjusting the model according to the modification index provided by Amos Version 4.0, the hypothesis was excepted.

To test hypothesis 2, multiple linear regression was used to analyze each of the hypothesized four groups of predictor variables (indicators). The predictor variables for each component were tested to predict a significant relationship between the criterion variable of Bahamas General Certificate of Secondary Education (1999) mathematics results (the indicator of mathematics achievement) and each of the four groups (components of OTL).

Hypothesis 2

There is a significant relationship between mathematics achievement and each of the four selected components of opportunity to learn.

Table 14a shows that the set of three classrooms' characteristics was significantly related to mathematics achievement as measured by the BGCSE mathematics examination results, F (3, 710) = 134.51, $p = .001$, $f^2 = .567$. The associated effect size ($f^2 = .567$) was large with the set of classrooms' characteristics accounting for a substantial amount (36%, $R^2 = .362$) of the variability in mathematics achievement. The significant individual classrooms' characteristics were as follows: course, F (1, 710) = 153.55, $p = .001$, $f^2 = .212$; teaching strategies, F (1, 710) = 142.56, p .001, $f^2 = .201$. The associated effect size ($f^2 = .212$) for course was medium to large with the variable accounting for about 14% ($R^2_{change} = .138$) of the variability in classrooms' characteristics. The associated effect size ($f^2 = .201$) for teaching strategies was medium to large with the variable accounting for about 13% ($R^2_{change} = .128$) of the variability in the classrooms' characteristics.

Table 14b shows that the set of three teachers' characteristics was significantly related to mathematics achievement as measured by the BGCSE mathematics examination results, F (3, 741) = 20.95, $p = .001$, $f^2 = .085$. The associated effect size ($f^2 = .085$) was small to medium with the set of teachers' characteristics accounting for about 8% ($R^2 = .078$) of the variability in mathematics achievement. The significant individual teachers' characteristics were as follows:

educational background, $\underline{F}$ (1, 741) = 34.94, $\underline{p}$ .001, $\underline{f}^2$ = .047; professional development, $\underline{F}$ (1, 741) = 42.39, $\underline{p}$ .001, $\underline{f}^2$ = .057. The associated effect size ($\underline{f}^2$ = .047) for educational background was small to medium with the variable accounting about 4% ($\underline{R}^2_{change}$= .043) of the variability in teachers' characteristics. The associated effect size ($\underline{f}^2$ = .057) for professional development was small to medium with the variable accounting for about 6% ($\underline{R}^2_{change}$= .057) of the variability in teachers' characteristics.

Table 14c shows that the set of six schools' characteristics was significantly related to mathematics achievement as measured by the BGCSE mathematics examination results, $\underline{F}$ (6, 640) = 14.42, $\underline{p}$ = .001, $\underline{f}^2$ = .135. The associated effect size ($\underline{f}^2$ = .135) was small to medium with the variable of schools' characteristics accounting for about 12% ($\underline{R}^2$ = .119) of the variability in mathematics achievement. The significant individual schools' characteristics were as follows: accomplishment, $\underline{F}$ (1, 640) = 27.08, $\underline{p}$ = .001, $\underline{f}^2$ = .042; strength of climate, $\underline{F}$(1, 640) = 10.66, $\underline{p}$ = .001, $\underline{f}^2$ = .017; power, $\underline{F}$ (1, 640) = 6.21, $\underline{p}$ = .013, $\underline{f}^2$ = .010; recognition, $\underline{F}$ (1, 640) = 16.27, $\underline{p}$ .001, $\underline{f}^2$ = .025; affiliation, $\underline{F}$ (1, 640) = 39.30, $\underline{p}$ .001, $\underline{f}^2$ = .061; commitment, $\underline{F}$ (1, 640) = 6.88, $\underline{p}$ = .001, $\underline{f}^2$ = .010. The associated effect size ($\underline{f}^2$ = .042) for accomplishment was small to medium and accounted for about 4% ($\underline{R}^2_{change}$= .037) of the variability in school characteristics. The associated effect size ($\underline{f}^2$ = .017) for strength of climate was small with the variables accounting for 2% ($\underline{R}^2_{change}$= .015) of the variability in schools' characteristics. The associated effect size ($\underline{f}^2$ = .010) of both power and commitment were small with each of the variables accounting for less than one percent of the variability in schools' characteristics. The associated effect size ($\underline{f}^2$ = .025) for recognition was small to medium with the variable accounting for about 2% ($\underline{R}^2_{change}$= .022) of the variability in schools' characteristics. The associated effect size ($\underline{f}^2$ = .061) of affiliation was small to medium with the variable accounting for about 5% ($\underline{R}^2_{change}$= .054) of the variability in school characteristics.

Table 14d shows that the set of four students' characteristics was significantly related to mathematics achievement as measured by the BGCSE mathematics examination results, $\underline{F}$ (4, 552) = 195.04, $\underline{p}$ = .001, $\underline{f}^2$ = 1.494. The associated effect size ($\underline{f}^2$ = 1.494) was large with the set of students' characteristics accounting for about 60% ($\underline{R}^2$ = .599) of the variability in mathematics achievement. The significant individual students' characteristics were as follows: socioeconomic status, $\underline{F}$ (1, 552) = 8.76, $\underline{p}$ .003, $\underline{f}^2$ = .017; attitude toward school, $\underline{F}$ (1, 552) = 20.46, $\underline{p}$ .001, $\underline{f}^2$ = .040; student's prior ability, $\underline{F}$ (1, 552) = 625.37, $\underline{p}$ .001, $\underline{f}^2$ = 1.197. The associated effect size for ($\underline{f}^2$ = .017) socioeconomic status was small with the variable accounting for less than one percent ($\underline{R}^2_{change}$= .007) of the variability in students' characteristics. The associated effect size ($\underline{f}^2$ = .040) for attitude toward school was small to medium with the variable accounting about 2% ($\underline{R}^2_{change}$= .016) of the variability in students' characteristics. The associated effect size ($\underline{f}^2$ = 1.197) for student's prior ability was very large with the variable accounting for 48% ($\underline{R}^2_{change}$= .480) of the variability in students' characteristics. Taken individually, student's prior ability seems to make significantly large positive (β = .718) contribution to mathematics achievement; attitude toward school was significantly but negatively (β = - .129) related to mathematics achievement; and parental involvement was not significantly related to mathematics achievement.

Summary

A summary of the results of the analyses of the sets of data follows:

1. The revised model (Figure 3) was tested using confirmatory factor analysis, AMOS Version 4.0 and the complete data set. According to the relevant literature (pp. 100-103) the model-data-fit was reasonable. The results indicated that three of the four components of teachers' characteristics, students' characteristics, schools' characteristics, and classrooms' characteristics contributed to the model, but the contribution of the set of classrooms' characteristics was not significant.

2a. There was a significant relationship between mathematics achievement and the set of teachers' characteristics that included educational background, years of teaching experience, and professional development. When taken individually, however, years of teaching experience was not significantly related to mathematics achievement, and professional development was negatively related to mathematics achievement.

2b. There was a significant relationship between mathematics achievement and the set of schools' characteristics of commitment, affiliation, recognition, power, strength of climate, and accomplishment. However, when taken individually, strength of climate, recognition, and accomplishment were negatively related to mathematics achievement.

2c. There was a significant relationship between mathematics achievement and the set of classrooms' characteristics of course taking, manipulative use, and teaching strategies. However, when taken individually, manipulative use was not significantly related to mathematics achievement.

2d. There was a significant relationship between mathematics achievement and the set of students' characteristics of student's prior ability, socioeconomic status, attitude toward school, and parental involvement. However, when taken individually, parental involvement was not significantly related to mathematics achievement, and attitude toward school was negatively related to mathematics achievement.

2e. In order of effect size, the component of classrooms' characteristics was most important, followed by schools' characteristics, then students' characteristics, and lastly teachers' characteristics.

Discussion

Based on the model developed by TIMSS researchers (Schmidt & McKnight, 1995), this study investigated the relationship between opportunity to learn (OTL) and the four components of teachers' characteristics, schools' characteristics, students' characteristics, and classrooms' characteristics on the Bahamian school population. The findings of this study support the results that there was also a significant relationship between OTL and the three selected components of students' characteristics, schools' characteristics, and teachers' characteristics. Confirmation of the model for OTL firmly establishes the four components of teachers' characteristics, schools' characteristics, students' characteristics, and classrooms' characteristics as defining OTL. Further research is needed to sharpen the operational definitions of these four components. In particular, classrooms' characteristics needs further study since its relationship to OTL was not significant. There could be several reasons for this lack of significance. First, a direct measure of content of lesson taught, a very important indicator of the classrooms' characteristics, was beyond the scope of this study. Second, manipulative use and teaching strategies were self-reported by teachers. Some teachers did not have access to manipulatives such as graphing calculators, algebra tiles, and computers in their classrooms, or if they were available, they were reportedly not used by many of the teachers.

The review of relevant literature on teachers' characteristics indicated that mathematics teachers play a prominent role in increasing mathematics achievement. The findings of this research indicated that the set of teacher component that included professional development, teaching experience, and educational background were significantly related to mathematics achievement. Kinney (1997-1998) found that a successful professional development program appeared to foster positive student achievement. Waller (1932) found that a crucial element in motivating students to learn was the emotional bond they formed with their teachers. The results of recent research studies indicated that students enjoy greater satisfaction and experience higher achievement in classrooms that have personal student-teacher relationship, innovative teaching methods and clearly defined sets of rules (Moos, 1979). In response to the statements "teachers and students trust one another", and "teachers and students treat each other with respect" the students disagreed with both of these statements. The findings of this study indicated that teachers played a small but significantly negative role in their students' mathematics achievement. This finding implies that there was a reported lack of trust between teachers and students, a serious breach that should be addressed by the Bahamian Education institutions

There are two areas of concern with the set of components of teachers' characteristics in relation to achievement. First, the indicator years of teaching experience was not significantly related to mathematics achievement. A possible reason for this might be found in the changes in mathematics instruction that experienced teachers may not be aware of and, as a result, could not implement. Duke (1993) suggested that professional growth is a rare commodity among more experienced teachers. On the other hand, Irwin (1994) argued that when a person enters the teaching arena he or she is involved in a lifelong learning process that began before he or she entered a college of education and continues throughout his or her career. This study confirms that Irwin's view of lifelong learning for teachers is still an ideal, not yet reality.

Second, the findings of this study showed a significant negative relationship between professional development and mathematics achievement. Restating, students of teachers who reported attending more mathematics workshops and conferences did not do as well in the Bahamas General Certificate of Secondary Education (BGCSE) mathematics examination as those who reported attending fewer workshops and conferences. Several possibilities could account for these findings. First, the transfer to classroom practice of information obtained from workshops and conferences may be minimal. Also, there may be a lack of follow-up after workshops or conferences to ensure theory to practice transfer. Teachers probably need collaborative environments that foster continuous learning and enhance their effectiveness in the classrooms (Morton, 1993). The workshops or conferences attended by mathematics teachers may not have been relevant to what they are required to teach. Often teachers are not consulted to determine what their needs are. For example, the major need might not be in content knowledge, but in pedagogy. This finding is supported by the results from The Rand Change

Agent Study (McLaughlin, 1991) that a teacher with new information about classroom processes does not necessarily apply this information in the classroom. One conclusion to be drawn from this study is that Bahamian mathematics teachers should participate in identifying future professional development programs that affect them. At the very least additional staff development should do no harm.

Although all indicators of the set of school components were significantly related to mathematics achievement, the findings of this study showed that school had a small to medium effect on mathematics achievement. Rogus (1983) found that two of the central components of successful schools are high expectations of, and communication with members of the school community. Johnson and Johnson (1979) suggested that the school's environment is largely the sum of the classrooms' environment within the school. Also, the perception by students and parents of what is happening in school is dependent on what is happening in the classrooms and how they perceive that students and teachers are interacting. The findings of this study indicated that three out of six of the indicators of school climate were negatively related to mathematics achievement: Strength of climate, recognition, and accomplishment were significantly negative, indicating that the students who were low on the climate scale were high on mathematics achievement and those who were high on the climate scale were low on mathematics achievement. This finding is not supported by the literature. Therefore, Bahamian schools should undertake a systematic program to improve school climate. This affects all aspects of the school, not just mathematics.

Although the set of classroom components were not significantly related to OTL, they were significantly related to, and made a large contribution to mathematics achievement. This finding is supported by the result of a study conducted by Goodlad (1982) and his associates who found that the level of achievement is dependent on what goes on in the classroom. The finding relating to OTL was probed earlier in the discussion. The relation of the set of classroom components to mathematics achievement deserves further discussion. The findings of this research also indicated that students in Bahamian classrooms are divided into at least three different curricular tracks: the track with students who did not write the BGCSE mathematics examination, the track with students who wrote the core level mathematics examination, and the track with students who wrote the extended level mathematics examination. Oakes and Lipton (1994) advised that tracking amplifies earlier differences that existed among students. For example, students with similar backgrounds show marked differences in their achievement when tracked in earlier grades. As students enter the secondary schools, having had no opportunity to catch up, the differences become even more pronounced. The findings of this study suggest that there were pronounced differences in mathematics achievement (as measured by the BGCSE mathematics examination) among Bahamian students and these differences relate to the classroom components, particularly the component of course taking.

With the large number of students in the lower tracks in most of the schools, manipulative use in the mathematics classroom could be used to help students develop and understand mathematical concepts, procedures, and other aspects of mathematics (Szendrei, 1996; Kober, 1991; Clements & McMillen, 1996); promote active learning, create motivation, and alleviate boredom (Kober, 1991); and improve students understanding of mathematics (Kennedy, 1986). Many research studies have shown that manipulative use has a positive effect on students achievement in mathematics (Kober, 1991). However, taken individually, in this study, manipulative use was not significantly related to mathematics achievement. Bahamian mathematics classes reportedly made minimal use of manipulatives. Therefore, a low relationship between manipulative and mathematics achievement is not surprising.

Students are the most important players in the learning process whether as passive observers or willing participants. It was no surprise that the set of student components of student's prior ability, attitude toward school, socioeconomic status and parental involvement made the largest contribution to mathematics achievement. Taken individually, the effect size indicated that student's prior ability made the largest contribution to mathematics achievement. Student's prior ability is determined by a combination of factors relating to home background and schooling history (Leder, 1992). Boyer (1993) proposed that students must have a solid foundation in the relevant school disciplines in order to achieve in those areas. Wolf (1977) found that socioeconomic status was directly related to achievement. Oakes (1985) argued that students' attitudes greatly affect the learning opportunities provided for them by their teachers. The findings of this study indicated that taken individually, parental involvement was the only member of the set that was not significantly related to mathematics achievement. In addition, taken individually, attitude toward school was found to be negatively related to mathematics achievement.

The finding of this study that parental involvement was not a significant factor in students' mathematics achievement was not supported by the literature. Some researchers have shown that parents play the most critical role in the educational achievement of their children (Boyer, 1993; Ballantine, 1989). Koerner (1999) found that parental involvement had a major impact on student achievement. Koerner found that 87% of the students who earned As or Bs reported that parental involvement and aid were crucial in their achievement; while 50% of those who received Cs or worse indicated that parents were not interested. Stevens (1996) indicated that the family supports achievement by restricting television watching time; promoting reading at home, insisting that students spend time doing homework; helping students with homework (if they can); and allowing them to spend extra time pursuing academic interests. Research studies have shown that parental involvement in the home has greater impact on children's learning than parental involvement at school (Lueder, 1998). Hence, one possible reason why parental involvement was found not to be significant in this study could be that the indicators used to measure parental involvement were largely school based. Additional parental involvement measures might increase its influence on students' mathematics achievement.

As a mathematics teacher in the Bahamian school system for many years, the researcher is aware of the many frustrations students face in mathematics classes. Over the years, many of these students have continually experienced failure in their mathematics classes. Therefore, it was not surprising that findings of this study indicated that attitude toward school was negatively related to mathematics achievement. Oakes (1985) suggested that students who experience success may develop positive attitudes toward school while students who experience failure may develop negative attitude toward school. This finding is supported.

The findings of this study indicated that according to effect size, the set of students' characteristics made the largest contribution (60%) to mathematics achievement. The order in which the other components contribute to mathematics achievement from highest to lowest was, classrooms' characteristics (36%), schools' characteristics (12%), teachers' characteristics (8%). This was an interesting finding. In the Bahamas, mathematics teachers are usually held accountable for students lack of mathematics achievement. Although the schools and classrooms are sometimes considered as possible causes, the students are never considered as a possible cause of their lack of mathematics achievement.

Conclusions

Based on the data presented in this study, the following conclusions can be made:

1. A dimension of opportunity to learn can be identified from the three selected components of teachers' characteristics, schools' characteristics, and students' characteristics.

2. Mathematics achievement was significantly related to each of the four selected components of teachers' characteristics, schools' characteristics, students' characteristics, and classrooms' characteristics.

3. Opportunity to learn was related to mathematics achievement.

4. Students' characteristics made the largest contribution to mathematics achievement when compared with schools' characteristics, teachers' characteristics, and classrooms' characteristics.

Implications and Recommendations

This study has some definite implications for the Bahamian school administrators and policy makers, teachers, students, and parents as schools seek to improve instruction and students' performance in mathematics throughout the Commonwealth of the Bahamas. Based on the results of this study, the Bahamian school administrators and policy makers should consider the following when planning school improvement strategies.

1. A needs assessment survey should be conducted before inservice/professional development programs are planned.

2. There should be follow up activities after inservice/professional development programs to ensure that theory is put into practice.

3. School administrators should make an effort to improve communication with their school community and let both teachers and students know that they have high expectations of them.

4. School administrators and teachers should develop a program to help students and parents understand the important role students must play in their learning.

5. School administrators should create a climate in their school that is conducive to learning, and is goal oriented.

6. School administrators should develop programs to improve students' attitudes toward school.

7. School administrators should encourage teachers to use diagnostic teaching from the primary grades onward when teaching mathematics, in order to determine the causes of students' weaknesses so that students are not continually subjected to failure in mathematics.

8. School administrators should develop a program of teacher collaboration so that mathematics teachers may support each other.

9. Teachers should be encouraged to use manipulatives in classrooms with students in the lower tracks.

10. School administrators should establish a mathematics laboratory, equipped with computers, calculators, mathematics textbooks, and manipulatives where students can go to seek help when they do not understand mathematical concepts, or to gain better understanding of mathematics.

11 Bahamian school administrators and policy makers should develop a set of OTL indicators to determine whether schools are providing students with appropriate opportunities to learn.

12. This research study should be duplicated to include a sample population from throughout the Commonwealth of the Bahamas.

13. Any future study on OTL on the Bahamian population should include observations of classroom activities and content coverage.

14. Future study should be conducted to examine the relationship between parental involvement in the home and mathematics achievement.

15. Further study should be conducted to evaluate the impact of manipulative use on student achievement.

Bahamian schools are poised to participate in the international efforts to study and improve teaching and learning. As future research on OTL and its components of teachers' characteristics, schools' characteristics, classrooms' characteristics, and students' characteristics are conducted, Bahamian schools should be considered as sites for international studies relating to these variables.

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APPENDIX

Table 3

List of the Opportunity to Learn Components, Indicators and Their Respective Measures

Construct	Indicator	Measure
Teachers' Characteristics	Educational Background	TQ 7, 8, 9
	# of Years Experience	TQ 6
	Professional Development	TQ 10
Students' Characteristics	Prior ability	BJC Mathematics Grades
	Socioeconomic Status	SQ 2
	Parental Involvement	SQ 5, 8, 9, 11, 12, 13
	Attitude toward School	SQ 14, 15, 16, 17
Schools' Characteristics	Commitment	SQ 23, 28, 35
	Strength of climate	SQ 32
	Accomplishment	SQ 19, 27, 29, 33, 38
	Recognition	SQ 20, 22, 30, 34
	Power	SQ 24, 25, 26, 31
	Affiliation	SQ 21, 36, 37
Classrooms' Characteristics	Course Taking	SQ 6, 7
	Manipulative Use	TQ 15 g-15k
	Instructional Strategies	TQ 15a-15e, TQ 11, 12,13

Note: TQ: Teacher's Questionnaire; SQ: Student's Questionnaire

Figure 2

Second Order Original Structural Equation Model

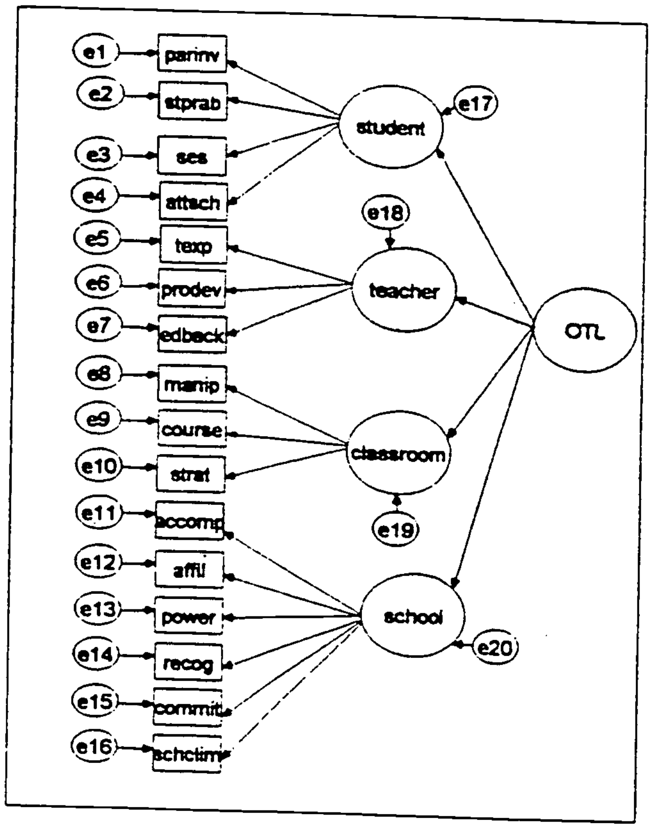

Figure 2. The second order original structural equation model: Relationship between (OTL) opportunity to learn and the components of teacher, student, school, and classroom as measured by the indicator variables of educational background (edback), teaching experience (texp) professional development (prodev), student prior ability (stprab), socioeconomic status (ses), parental involvement (parinv) attitude toward school (attsch), commitment (commit), strength of climate (schclim), accomplishment (accomp), recognition (recog), power, affiliation (affil), use of manipulative (manip), teaching strategies (strat), and course taking (course)

Figure 3

A Revised Second Order Original Structural Equation Model

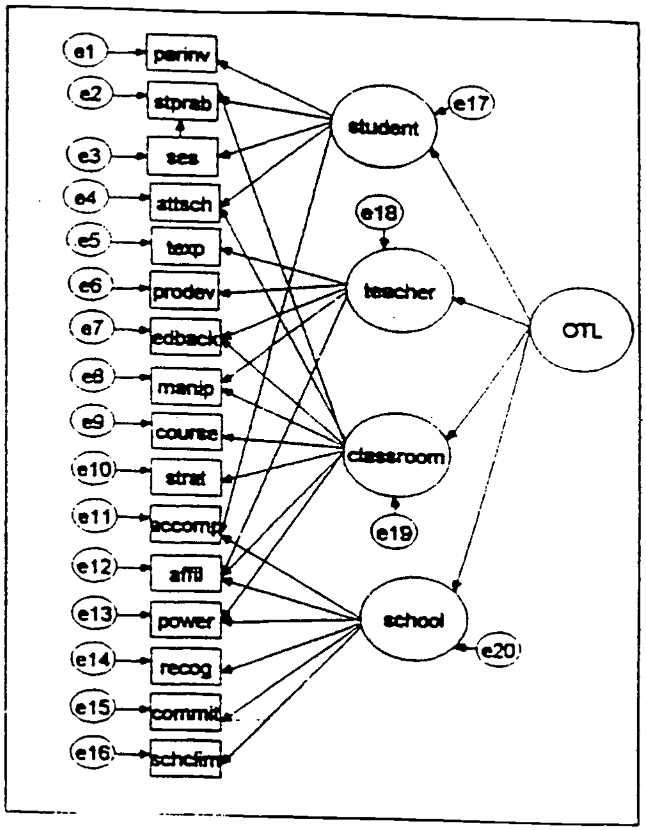

Figure 3. A revised second order original structural equation model with eight new paths added: Relationship between (OTL) opportunity to learn and the components of teacher, student, school, and classroom as measured by the indicator variables of educational background (edback), teaching experience (texp) professional development (prodev), student prior ability (stprab), socioeconomic status (ses), parental involvement (parinv), attitude toward school (attsch), commitment (commit), strength of climate (schclim), accomplishment (accomp), recognition (recog), power, affiliation (affil), use of manipulative (manip), teaching strategies (strat), and course taking (course).

Table 12

Standardized Maximum Likelihood Estimates for Parameters of the Revised Model for the OTL Data Set

Cause	Effect Variable			
	Teacher	Student	School	Classroom
OTL	.18	.64	.81	-.09 ns
Strength of climate	-	-	.35	-
Educational background	.44	-	-	.30
Professional development	.73	-	-	-
Years of teaching experience	-.38	-	-	-
Student prior ability	-	-.11 ns	-	.42
Socioeconomic status	-	-.03 ns	-	-
Attitude toward school	-	.67	-	-
Commitment	-	-	.73	-
Affiliation	-.14	-	.75	-
Power	-	-	.41	.10 ns
Accomplishment	-	.24	.75	
Recognition	-	-	.63	-
Instructional strategies	-	-	-	.94
Manipulative use	.14	-	-	.39
Course	-	-	-	.16

Note: ns means that the correlations are not significant at $p < .05$.

All other correlations are significant at $p < .05$.

- means no correlation.

Table 13

Re-specification of Opportunity to Learn Components According to Indicators.

Construct	Indicator
Teachers' characteristics	Number of years experience
	Educational background
	Professional development
	Affiliation*
	Use of manipulatives*
Classrooms' characteristics	Use of manipulatives
	Instructional strategies
	Course
	Student's prior ability*
	Power*
	Affiliation*
	Educational background*
	Attitude toward school*
Schools' characteristics	Commitment
	Strength of climate
	Accomplishment
	Recognition
	Power
	Affiliation
Students' characteristics	Attitude toward school
	Socioeconomic status
	Accomplishment*
	Parental Involvement
	Student's Prior Ability

Note: * indicated new indicator of the respective components.

Table 14a

Hypothesis 2: Results of Predicting the Bahamas General Certificate of Secondary Education Mathematics Scores from the Classroom Component of Opportunity to Learn

Source	df	MS	F	p	R^2_{change}	f^2 [1]	β
Course taking	1	412.16	153.55	.001[a]	.138	.212	.379
Use of manipulatives	1	.99	.37	.545[a]			.019
Teaching strategies	1	382.66	142.56	.001[a]	.128	.201	.391
Classroom	3	361.06	134.51	.001[b]	.362	.567	
Residual	710	2.68					

Note: a. Tested against the full model.

b. Predictors in the full model: (Constant), Teaching strategy, Course taking, Use of manipulatives.

[1] $f^2 = \frac{r^2_{change}}{1 - r^2_{full}}$, $f^2 = .02$ small effect; $f^2 = .15$ medium; $f^2 = .35$ large (Cohen, 1988)

Table 14b

Hypothesis 2: Results of Predicting the Bahamas General Certificate of Secondary Education Mathematics Scores from the Teacher Component of Opportunity to Learn

Source	df	MS	F	p	R^2_{change}	f^2	β
Professional development	1	165.43	42.39	.001[a]	.043	.047	-.244
Educational background	1	136.38	34.94	.001[a]	.053	.057	.219
Years of teaching experience	1	.25	.06	.800[a]			-.009
Teacher	3	81.76	20.95	.001[b]	.078	.085	
Residual	741	3.90					

Note: a. Tested against the full model.

b. Predictors in the full model: (Constant), Years of teaching experience, Professional development, and Educational background.

Table 14c

Hypothesis 2: Results of Predicting the Bahamas General Certificate of Secondary Education Mathematics Scores from the School Component of Opportunity to Learn

Source	df	MS	F	p	R^2_{change}	f^2	β
Affiliation	1	142.99	39.30	.001[a]	.054	.061	.308
Power	1	22.61	6.21	.013[a]	.009	.010	.100
Strength of Climate	1	38.78	10.66	.001[a]	.015	.017	-.129
Recognition	1	59.19	16.27	.001[a]	.022	.025	-.183
Commitment	1	25.03	6.88	.009[a]	.009	.010	.129
Accomplishment	1	98.52	27.08	.001[a]	.037	.042	-.244
School	7	52.47	14.42	.001[b]	.119	.135	
Residual	640	3.64					

Note: a. Tested against the full model.

b. Predictors in the full model: (Constant), Affiliation, Power, Strength of Climate, Recognition, Commitment, and Accomplishment.

Table 14d

Hypothesis 2: Results of Predicting the Bahamas General Certificate of Secondary Education Mathematics Scores from the Student Component of Opportunity to Learn

Source	df	MS	F	p	R^2_{change}	f^2	β
Socioeconomic status	1	13.78	8.76	.003[a]	.007	.017	.084
Parental involvement	1	3.60	2.29	.131[a]	.002		.043
Attitude toward school	1	32.20	20.46	.001[a]	.016	.04	-.129
Student's prior ability	1	983.37	625.37	.001[a]	.480	1.197	.718
Student	4	306.87	195.04	.001[b]	.599	1.494	
Residual	552	1.57					

Note: a. Tested against the full model.

b. Predictors in the full model: (Constant), Socioeconomic status, Parental involvement, Attitude toward school, and Student's prior ability.

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